

We claim:

1. A method for temperature-independent determination of a concentration of a probe gas in a sample, said method comprising:

- a) selecting a temperature range;
- b) selecting a first spectroscopic technique for the detection of said probe gas;
- c) determining a probe temperature function of said probe gas over said temperature range for said first spectroscopic technique;
- d) identifying in said sample a reference gas;
- e) selecting a second spectroscopic technique for the detection of said reference gas;
- f) determining a reference temperature function of said reference gas over said temperature range for said second spectroscopic technique such that a ratio of said probe temperature function to said reference temperature function is substantially constant over said temperature range;
- g) measuring a probe reaction of said probe gas and a reference reaction of said reference gas with said first spectroscopic technique and said second spectroscopic technique; and
- h) deriving said concentration from said probe reaction and said reference reaction.

2. The method of claim 1, wherein said first spectroscopic technique and said second spectroscopic technique are the same.

3. The method of claim 1, wherein said first spectroscopic technique and said second spectroscopic technique comprise absorption spectroscopy employing

a test beam, said probe reaction is a probe absorption of a wavelength component of said test beam chosen for the detection of said probe gas, and said reference reaction is a reference absorption of a wavelength component of said test beam chosen for the detection of said reference gas.

4. The method of claim 3, wherein said probe absorption and said reference absorption result from absorptive transitions.

5. The method of claim 4, wherein said absorptive transitions are selected from the group consisting of rovibrational transitions and rovibronic transitions of molecular gas species and from electronic transitions of atomic gas species.

6. The method of claim 3, wherein said probe absorption and said reference absorption result from absorptive transitions and a vector difference between said ratio and a constant value is used to select said absorptive transitions.

7. The method of claim 1, wherein said first spectroscopic technique and said second spectroscopic technique use at least one broadband light source.

8. The method of claim 7, wherein said reference temperature function is obtained from a linear combination of a first reference temperature function associated with a first broadband source and a second reference temperature

6 function associated with a second broadband
7 source.

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1 9. The method of claim 7, wherein said probe
2 temperature function is obtained from a linear
3 combination of a first probe temperature
4 function associated with a first broadband
5 source and a second probe temperature function
6 associated with a second broadband source.

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1 10. The method of claim 1, wherein said first
2 spectroscopic technique and said second spectroscopic
3 technique use narrowband sources having spectral
4 widths narrower than corresponding transition
5 linewidths in said probe gas and said reference gas.

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2 11. The method of claim 10, wherein said reference
3 reaction comprises a first transition and a
4 second transition, and said reference
5 temperature function is obtained from a linear
6 combination of a first reference temperature
7 function of said first transition and a second
8 reference temperature function of said second
9 transition.

1 12. The method of claim 10, wherein said probe
2 reaction is an attenuation resulting from a
3 probe transition and said at least one
4 narrowband source has a spectral width narrower
5 than the linewidth of said probe transition.

6
1 13. The method of claim 1, further comprising:
2 a) deriving from said probe reaction and from said
3 reference reaction a measured concentration

ratio of said probe gas to said reference gas;
and

b) using said measured concentration ratio in
deriving said concentration.

14. The method of claim 1, wherein said temperature range
is selected between a low temperature T_L
corresponding to a lowest temperature of said sample,
and a high temperature T_H corresponding to a highest
temperature of said sample.

15. The method of claim 14, wherein said probe
temperature function and said reference
temperature function are indexed to a reference
temperature T_{ref} selected such that $T_L \leq T_{ref} \leq T_H$.

16. The method of claim 1, wherein said reference gas is
a stable gas having a functional relationship with
said probe gas.

17. The method of claim 14, wherein said functional
relationship is used in deriving said
concentration.

18. The method of claim 1, wherein said probe gas is CO.

19. The method of claim 18, wherein said reference
gas is CO₂.

20. The method of claim 19, wherein said sample
is a vehicle exhaust sample.

21. The method of claim 1, wherein said sample exhibits
non-uniformities selected from temperature non-

uniformities, pressure non-uniformities and gas composition non-uniformities.

22. The method of claim 1, wherein said ratio of said probe temperature function to said reference temperature function is substantially equal to one over said temperature range.

23. An apparatus for temperature-independent determination of a concentration of a probe gas in a sample over a temperature range by using a reference gas in said sample, said apparatus comprising:

- a) a spectrometer for employing a first spectroscopic technique to measure a probe reaction of said probe gas and for employing a second spectroscopic technique to measure a reference reaction of said reference gas;
- b) a processing unit for determining a probe temperature function of said probe gas over said temperature range for said first spectroscopic technique, and for determining a reference temperature function of said reference gas over said temperature range for said second spectroscopic technique such that a ratio of said probe temperature function to said reference temperature function is substantially constant over said temperature range; and
- c) a computing unit for deriving said concentration from said probe reaction and said reference reaction.

24. The apparatus of claim 23, further comprising a unit for calculating said ratio.

25. The apparatus of claim 23, wherein said spectrometer comprises at least one broadband light source.

26. The apparatus of claim 23, wherein said spectrometer comprises at least one narrowband source.

27. The apparatus of claim 26, wherein said narrowband source comprises a single-longitudinal-mode laser.

28. The apparatus of claim 23, further comprising optics for directing a test beam of said spectrometer.

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